25-FT Space Simulator

Facility Description
Building 150

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Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

The Jet Propulsion Laboratory maintains NASA-owned environmental test facilities for research, development and qualification testing of space related test articles. These facilities are available to other government agencies and to private industry.

The 25-Ft Space Simulator (SS) was originally built in 1961. It has been modified since then to satisfy expanding space simulation and cleanliness requirements. Ten cryopumps and two turbomolecular pumps pump today's facility. The inside walls are lined with temperature controlled shrouds. Solar simulation is provided by an array of Xenon arc lamps, capable of solar eclipses and radiation levels below and above one solar constant.

The 25-Ft SS has supported many space flight programs for both NASA and private industry. The test capabilities include:

- Test article thermal response to simulated space environments (including solar simulation).
- Test article contamination controlled bake outs.
- Qualification and functional testing of spacecraft and instruments.

The facility is capable of supporting 24-hour operations over extended periods of time. Past test durations have exceeded one month.

A. Chamber Details

The chamber is a cylinder approximately 85 ft (25.9 m) high and 27 ft (8.2 m) in diameter. The test volume is 20ft (6.1 m) in diameter, and 25 ft (7.6 m) high for solar operation. For non-solar testing, the test area is approximately 70 ft (21.3 m) high. The chamber access door is at ground level. Door dimensions are nearly 15 ft wide (4.6 m) x 25 ft high (7.6 m).

Test item installation is accomplished using a monorail crane. The test item is picked up in the high bay and the crane rail is then moved into the chamber supporting the test item. The test item is either hard mounted to stanchions that protrude through the floor, or is suspended by cables attached to hard points that are mounted at various levels around the chamber.

The high vacuum system was upgraded in 1992/1993 and presently consists of ten, 45,000 liter/second cryopumps and two, 2,200 liter/second turbomolecular pumps. The chamber can be evacuated from atmospheric pressure to 5 $x10^{-5}$ torr in approximately three hours. There are four stages of pumping:

- An Axial Compressor, which will evacuate the chamber from atmospheric pressure to a pressure of 70 torr in about fifteen minutes.
- A mechanical pumping system consisting of 4 pairs of mechanical pumps each of which has a booster pump. The mechanical pumps take the chamber from approximately 70 torr to 11 torr.
- Two large vacuum booster pumps, which start automatically at 11 torr and take the pressure down to 20 millitorr.
- The last stage consists of 10 Cryo Pumps and 2 Turbo Pumps, which can take the chamber pressure down to 1 x 10^{-6} range.

The chamber shrouds are louvered aluminum panels that are painted black on all surfaces that face the test volume. The temperature of the shrouds can be maintained at -185°C by cooling with liquid nitrogen. Intermediate temperatures between -125° C to +100° C can be obtained by either cooling or heating gaseous nitrogen, which is pumped through the shrouds.

The off-axis solar simulation system consists of:

- An array of 37 Xenon gas filled arc lamps, (each with a maximum power of 30 kw).
- An integrating lens unit, which mixes the light from the lamps to form a uniform beam.
- A penetration window made of fused quartz.
- A 23-ft diameter-collimating mirror mounted at the top of the chamber (temperature controlled with gaseous nitrogen over a range from -75°C to +150°C).

Four different solar beam diameter/solar intensity configurations can be achieved by using combinations of two integrating lens units and two collimating mirrors. The accompanying table presents details of these configurations.

Integrating Lens Units (ILU)

	ILU #2	ILU #4
23-Ft Collimating Mirror	SSB-15 (15-ft Diameter Solar Beam)	SSB-18.5 (18.5-ft Diameter Solar Beam
Lamps Available	37	37
Maximum Solar Intensity (37 lamps at 30 kw)	2.5 Solar constants ($3{,}400$ w/m^2)	2.0 Solar Constants ($2{,}660$ w/m^2)
Collimation Half Angle		1.1 Degrees (96.2% of energy is within 1°)
Uniformity		+0.6% to –1.4%
15-Ft Collimating Mirror	SSC-8.5 (8.5-ft Diameter Solar Beam)	SSC-11 (11-Ft Diameter Solar Beam
Lamps Available	37	37
Maximum Solar Intensity (37 lamps at 30 kw)	11.0 Solar Constants ($14{,}900$ w/m^2)	6 Solar Constants ($8{,}160$ w/m^2)
Collimation Half Angle	2 degrees	TBD
Uniformity	± 5%	TBD

Test article structural support within the chamber can be provided in two ways. First, the floor shroud has openings that allow test article support structures to be hard-mounted to support columns in the chamber end bell. These columns rest on an isolated seismic mass below the chamber end bell. Secondly, wall-mounted attachment points, each capable of a 10,000 pound vertical load, can be used to attach suspension cables or fixed hardware.

The chamber has a variety of penetrations in the cylinder wall and end bell to provide feed throughs for instrumentation, power, and temperature control systems.

B. Power Supplies

Facility power is supplied by Southern California Edison and is available at the following ratings:

- 120 vac, 1 phase
- 208 vac, 3 phase
- 480 vac, 3 phase

In the event of a loss of Edison supplied power, two emergency power generators provide power to the primary chamber controls, the Data Acquisition System, and the customer's equipment (as requested).

C. Customer Ground Support Equipment Area

An area for customer ground support equipment is available inside the 25-ft Space Simulator building adjacent to the control room. Power can be made available at the following ratings.

- 120 vac, 1 phase
- 208 vac, 3 phase
- 480 vac, 3 phase

D. S^3 Data Acquisition System (DAS)

The standard instrumentation capabilities of the DAS 25-ft Space Simulator are listed below. Other special or additional instrumentation can be provided and/or accommodated as needed.

Test Article Instrumentation:

Thermocouples	-	600 channels, type E or type T
RTD	-	40 channels
Heater Control	-	60 power supplies (75 watts each)

Facility Data:

Thermocouples	-	140 channels (shrouds, mirror, etc.)
Chamber Pressure	-	6 ion gauges
Solar	-	1 Kendall Cavity Radiometer
Contamination	-	3 TQCM's

E. Additional Options

Video capture is also available using a system called STAR, (Satellite Test Assist Robot). Star consists of two video cameras, and an IR (Infra Red) camera. One video has a fixed lens and the other has a zoom lens. The IR camera can be used to monitor temperature gradients over the visible surfaces of the test item. These cameras are attached to a pan and tilt unit, which is mounted on a beam and can be raised to an elevation of approximately 30 feet. This allows viewing the backside, top and possibly bottom of the test item. This information can be recorded on a VCR.

An RGA (Residual Gas Analyzer) is available for monitoring the gases in the chamber.

F. Clean Room and Test Article Handling Provisions

There is an air lock and a class 10,000 clean room (35 ft x 30 ft x 32 ft, LWH) that is available for test article assembly and system checkout prior to environmental testing. A 10-ton crane is available in these rooms.

Test article mobility within the clean room, air lock and high bay, adjacent to the chamber, is provided by overhead cranes. Loading test articles into the chamber can be accomplished using either the monorail crane, which extends into the chamber or a ramp system, which can be mounted on the floor of the chamber.